Attachment B
SWIFT Research Center SWIFT Water Quality Targets

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Acronyms and Abbreviations

µg/L	micrograms per liter
BAF	biologically active carbon filtration
CCP	critical control points
CFE	combined filter effluent
COP	Critical Operating Point
CT	Contact Time
EPA	U.S. Environmental Protection Agency
GAC	Granular Activated Carbon
gpm	gallons per minute
HRSD	Hampton Roads Sanitation District
IFE	Individual Filter Effluent
LRV	Log Removal Value
MCL	Maximum Contaminant Levels
mg/L	milligrams per liter
mJ/cm^2	mili-joule per square centimeter
MPN	most probable number
NP	Nansemond Treatment Plant
NTU	nephelometric turbidity units
PAS	Potomac Aquifer System
pCi/L	picocuries per liter
SAT	soil aquifer treatment
SWIFT	Sustainable Water Initiative for Tomorrow
SWIFTRC	SWIFT Research Center
TBD	to be determined
TDS	total dissolved solids
TOC	total organic carbon
UIC	Underground Injection Control
UV	ultraviolet
UVT	UV Transmittance

SECTION 1

SWIFT Program Overview

The Hampton Roads Sanitation District (HRSD) Sustainable Water Initiative for Tomorrow (SWIFT) will add multiple advanced water treatment processes to select HRSD wastewater treatment facilities to produce a highly treated water (SWIFT Water) that exceeds drinking water standards and is compatible with the receiving aquifer. Secondary effluent from up to seven of HRSD's existing treatment facilities will be treated at SWIFT facilities and SWIFT Water will be recharged into the Potomac Aquifer System (PAS) to counter depleting aquifer levels. At full-scale, HRSD intends to recharge over 100 million gallons per day of SWIFT Water that will significantly reduce the nutrient load to the sensitive Chesapeake Bay and provide significant benefit to the region by limiting saltwater intrusion, reducing land subsidence, and providing a sustainable source of groundwater, a necessity for continued economic expansion in the region.

The SWIFT Research Center (SWIFTRC) involves a nominal 1 million gallons per day advanced treatment facility and injection well located at the Nansemond Treatment Plant (Suffolk, VA) that will begin production and recharge in spring 2018. The primary purpose of the SWIFTRC is to demonstrate at a meaningful scale that advanced treatment will produce SWIFT Water that meets primary drinking water standards and is compatible with the groundwater chemistry and minerals composing the PAS. HRSD will collect at least 18 months of operational data to inform and optimize the design and construction and to define permitting requirements for the full-scale SWIFT facilities. The purpose of this document is to define the SWIFT Water quality targets for the SWIFTRC and demonstrate how the targets will be achieved. While the targets identified in this document provide the basis for SWIFTRC operation and evaluation of compliance, it is not assumed that these will automatically carry forward to the regulatory requirements associated with full-scale SWIFT facility permits. The data gathered from the SWIFTRC will be used to inform management decisions regarding the appropriate regulatory targets for full-scale implementation. This document, Attachment B, is an attachment within the Underground Injection Control (UIC) Inventory Information Package ("UIC Inventory").

SECTION 2

SWIFT Research Center

2.1 General Description and Purpose

The primary objectives of the SWIFTRC are to collect operational and aquifer response data to demonstrate the viability of the SWIFT program and to facilitate regulatory discussions for the full-scale facilities. Secondary objectives for the SWIFTRC include:

- Provide a facility for staff/operator training.
- Provide a facility for public education.
- Provide a flexible treatment facility that supports technology/process changes, improvements, and optimization.
- Monitor the migration of injectate constituents through the aquifer.
- Support the level of automation consistent with the HRSD Strategic Automation Plan.

The SWIFTRC is designed to treat a continuous flow of 700 gallons per minute (gpm) of secondary effluent from the existing Nansemond Treatment Plant (NP) in Suffolk, VA. The SWIFTRC is located at the NP site as is the PAS recharge well and the surrounding monitoring wells. A future, full-scale SWIFT facility is also intended to be located at NP for the full secondary effluent flow; this will be a separate independent system that will be designed and constructed as part of SWIFT build-out. The SWIFTRC was designed for a 20-year lifetime and will continue operation even after the full-scale facility is operational. Over this extended period, the SWIFTRC will serve for advanced treatment process research and development, public education and outreach, and PAS monitoring.

An independent SWIFT oversight structure similar to the Occoquan Watershed Monitoring Program formed to provide oversight of indirect potable reuse in northern Virginia, has been proposed in draft legislation for consideration in the 2018 Virginia General Assembly session. It is envisioned that this group will serve to monitor the performance of the treatment processes, observe the aquifer response to the recharge, and ensure compliance with SWIFT program performance targets. This program will provide on-going oversight of full-scale SWIFT facilities in order to demonstrate that all SWIFT facilities are in compliance with the performance targets.

There are two identified end uses for the SWIFT Water produced at the SWIFTRC: recharge to the PAS and periodic tasting events associated with SWIFTRC tours. SWIFT Water will be continuously pumped into the recharge well after confirming that all water quality targets are met. A small side stream of the SWIFT Water (1-2 gpm) will be periodically pumped to a flow-through tank, free chlorinated, and made available for consumption during tasting events held at the SWIFTRC. Tasting events are intended to be voluntary in nature and will be offered during public tours and events.

2.2 Process Design Summary

HRSD conducted room-scale pilot testing in 2016 of two treatment processes: a Granular Activated Carbon (GAC)—or “carbon-based”—advanced treatment process and a reverse osmosis (RO)—or “membrane-based”—advanced treatment process. Pilot performance for key constituents during approximately five months of membrane operation and ten months of carbon operation is summarized in Table 1-1 and further detailed in a slide deck provided as Attachment H. The available data demonstrates that both treatment processes can effectively achieve the identified SWIFT Water quality targets (Attachment B). A PAS compatibility analysis showed that due to the high total dissolved solids

(TDS) in the receiving aquifer, the carbon-based effluent is more suitable for recharge; the membrane-based effluent would require significant salt addition to the finished water to achieve PAS compatibility targets. As expected, the removal of total organic carbon (TOC) also differs between the two pilot processes (see Attachment H, slides 42-59 for detailed TOC removal performance). To better understand the potential risk associated with TOC concentrations, HRSD conducted extensive emerging contaminant monitoring, evaluated disinfection byproduct formation potential, and submitted samples for a suite of bioassay testing (refer to Table 1-1 for data on emerging contaminants and bioassay monitoring, disinfection by-product (DBP) formation potential is documented in Attachment H, slides 83-84). Given the similar performance of both pilot trains with respect to emerging contaminant removal and disinfection byproduct formation potential, the higher TOC concentration present in the pilot effluent from the carbon train does not equate to a higher human health risk. This is further supported by bioassay testing which is designed to detect the potential risk associated with the full suite of contaminants present in a water sample. In the bioassay testing of the pilot effluent samples, neither the carbon nor the membrane train elicited an endocrine or cytotoxic response. Further, the carbon unit will be operated to target a 4 milligrams per liter (mg/L) TOC (monthly average) which is consistent with the Upper Occoquan Service Authority's indirect potable reuse limit of 10 mg/L chemical oxygen demand (monthly average).

Table 1-1. Comparison of Water Quality Data for Pilot Processes

Parameter	Pilot Effluent[1]	
	Carbon Train, Low Rate	**Membrane Train**
Primary Maximum Contaminant Levels (MCLs) (Refer to slide 64 in App H)	No exceedances of MCLs	No exceedances of MCLs
Secondary MCLs (Refer to slide 66 in App H)		
TDS only SMCL exceeded, 99th percentile	635 mg/L	29 mg/L
Pathogen Indicators (Refer to slides 69-70, 80-81 in App H)		
Total coliform, 95th percentile	<1 MPN/100 milliliters	1 MPN/100 milliliters
E coli, 95th percentile	<1 MPN/100 milliliters	<1 MPN/100 milliliters
MS2 Challenge Test	> 8-log removal	> 8-log removal
Pepper Mild Mottle Virus	>5.9 log removal	>5.9 log removal
Total # Quantified Emerging Contaminants (Refer to slides 71-74 in App H)	13	13
Total # Unique Emerging Contaminant Detections[2]	11	7
Bioassays (Refer to slides 75-77 in App H)		
Estrogen Receptor Assay	No response	No response
Glucocorticoid Receptor Assay	No response	No response
Cytotoxicity Assay	No response	No response
P53 Assay	No response	No response
Public Health Indicators (Refer to Slide 67 in App H)		
1,4-dioxane	0.26-0.39 micrograms per liter (µg/L)[3]	<0.07 µg/L[4]
17-β-estradiol	<0.005 µg/L[5]	<0.005 µg/L[6]

Table 1-1. Comparison of Water Quality Data for Pilot Processes

Parameter	Pilot Effluent[1]	
	Carbon Train, Low Rate	Membrane Train
DEET	<0.010 µg/L[5]	<0.010-0.012 µg/L[6]
Ethinyl estradiol	<0.005 µg/L[5]	<0.005 µg/L[6]
NDMA	<0.2-2.5 nanograms per liter (ng/L)[7]	<2-7.9 ng/L[8]
Perchlorate	< 4 µg/L[9]	< 4 µg/L[9]
PFOA + PFOS	<60 ng/L[10]	<60 ng/L[10]
tris(2-carboxyethyl) phosphine (TCEP)	<0.010 µg/L[5]	<0.010 µg/L[6]
Treatment Efficacy Indicators (Refer to Slide 68 in App H)		
Cotinine	<0.010 µg/L[5]	<0.010 µg/L[6]
Primidone	Range: <0.005 – 0.0052 µg/L[5]	<0.005 µg/L[6]
Phenytoin (Dilantin)	<0.02 µg/L[5]	<0.02 µg/L[6]
Meprobamate	<0.005 µg/L[5]	<0.005 µg/L[6]
Atenolol	<0.005 µg/L[5]	<0.005 µg/L[6]
Carbamazepine	<0.005 µg/L[3]	<0.005 µg/L[4]
Estrone	<0.005 µg/L[3]	<0.005 µg/L[4]
Sucralose	Range: <0.1 - 6.0 µg/L[3]	Range: <0.1 - 0.39 µg/L[4]
Triclosan	<0.010 µg/L[3]	<0.010 µg/L[4]

[1] all items with a "<" were non-detect and noted as < the detection limit. Some parameters, like primidone, had a mixture of detections and non-detections.

[2] Carbon-train detections: Cyanazine, Sucralose, Iohexal, Azithromycin, 4-nonylphenol, Lidocaine, Acesulfame-K, 4-tert-octylphenol, BPA, Linuron, Sulfamethoxazole. Membrane train detections: Cyanazine, Sucralose, DEET, 4-nonylphenol, Butalbital, 4-tert-octylphenol, 2,4-D

[3] Based on 6 samples in pilot effluent.

[4] Based on 1 sample in pilot effluent.

[5] Based on 12 samples in pilot effluent.

[6] Based on 9 samples in pilot effluent.

[7] Based on 2 samples in pilot effluent.

[8] Based on 20 samples in pilot effluent.

[9] Based in 10 samples in pilot feed; only 2 data points available in pilot effluent for carbon (results <4 µg/L).

[10] Based on 4 samples in pilot feed; not sampling pilot effluent.

The effectiveness of the carbon-based process during pilot testing, the overall lower capital and operational costs associated with the carbon-based process (relative to membrane-based processes), and the compatibility between carbon-based effluent and the PAS led HRSD to select the carbon-based process for the SWIFTRC. Alternatives or enhancements to the selected carbon-based process may be considered for full-scale facilities, specific to the site.

A process flow diagram of the SWIFTRC treatment process is shown in Figure 2-1. The full treatment process consists of rapid mix with coagulant addition, flocculation, and sedimentation, ozone oxidation, biologically active carbon filtration (BAF), GAC adsorption, and ultraviolet (UV) disinfection.

Chlorine will be added prior to the injection well to provide secondary disinfection and to prevent biological fouling of the well. The system will allow for the controlled addition of either free chlorine or preformed monochloramine. Monochloramine residual will initially be used during well injection because it results in lower formation of regulated disinfection by-products and it is more stable. However, if higher disinfection is desired (e.g., during tasting events) or monochloramine results in elevated formation of unregulated disinfection byproducts (e.g., nitrosamines), a free chlorine residual may be used.

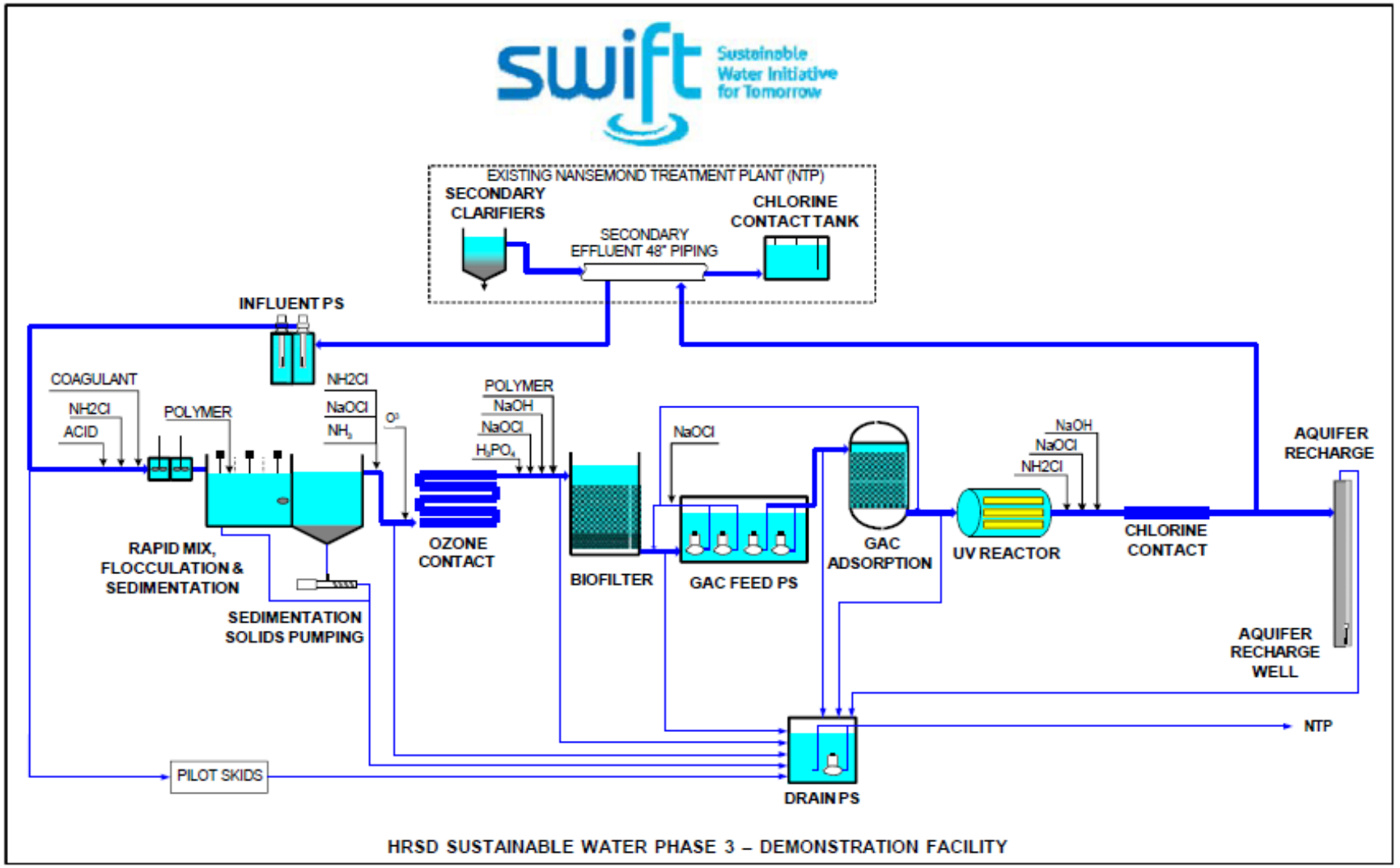

Figure 2-1. SWIFTRC Process Flow Diagram

Following is a brief description of each treatment process with accompanying design criteria listed in Table 2-1:

- **Rapid Mix, Flocculation, Sedimentation:** Chemical coagulant will be added to the water to remove solids and organics through the formation and settling of chemical flocculation and to prepare the water for effective filtration.
- **Ozone Oxidation:** Ozone will be added to oxidize high molecular weight organics for downstream removal in biofiltration and for direct oxidation of trace organics (e.g., contaminants of emerging concern such as pharmaceutical and personal care products). Disinfection of pathogens will also be achieved with ozone addition, although this is a secondary goal because other treatment processes are primarily targeting disinfection (i.e., filtration, UV).
- **Biofiltration:** Deep-bed granular media filters will provide biological removal of organic matter and particle and pathogen removal. Low filtered water turbidity (<0.15 nephelometric turbidity units [NTU]) will be targeted to ensure proper pathogen removal consistent with the design and operation of drinking water filters (see Critical Control Point section).
- **GAC Adsorption:** Granular activated carbon will provide removal of trace organics through biological and adsorption mechanisms. GAC media will be regenerated to meet the proposed regulatory limit for total organic carbon (see Proposed Regulatory Limits section).
- **UV Disinfection:** UV irradiation will provide disinfection of the water before groundwater injection. A UV dose that is significantly higher than typically used for drinking water is being provided for SWIFTRC to allow for greater than 4-log virus removal, but this will be revisited before future full-scale implementation after reviewing SWIFTRC water quality results.
- **Chlorine Disinfection:** A monochloramine or free chlorine residual will be maintained in the injected water to provide secondary disinfection and to limit biological fouling of the well. Note that when free chlorine is used the contact time (CT) provided by the chlorine contact tank provides additional virus disinfection credit.

Table 2-2 shows the primary chemical addition locations.

Table 2-1. SWIFTRC Treatment Process Design Criteria

Process/Criteria	Value	Units
Rapid Mix Velocity Gradient	1,000	s^{-1}
Number of Flocculation Stages	3	#
Flocculation Stage Residence Time, Each	15	Min
Design Sedimentation Projected Loading Rate	0.20	gpm/square foot
Maximum Ozone Dose	20	mg/L
Ozone Contactor Hydraulic Residence Time	8	Min
Number of BAFs	4	#
BAF Loading Rate, each	4	gpm/square foot
BAF Empty Bed Contact Time, all four filters in service	9.3	Min
BAF Carbon Media Depth	5	Ft
BAF Sand Media Depth	1	Ft
Number of GAC Reactors	2	#

Table 2-1. SWIFTRC Treatment Process Design Criteria

Process/Criteria	Value	Units
GAC Vessel Empty Bed Contact Time, combined two vessels	30	Min
Design UV Virus Log Removal Value	4	LRV
Design UV Dose	186	mJ/cm^2
Minimum UVT	85	%
Minimum UV Lamp Age & Lamp Fouling Factor, each	90	%
Chlorine Contact Virus Log Removal Value (if free chlorine disinfection is practiced)	4	LRV
Required Free Chlorine CT Value at Minimum Temp	4.80	mg/L-min
Chlorine Contact Hydraulic Residence Time	5	Min

LRV = Log Removal Value
mJ/cm^2 = milijoules per square centimeter
UVT =ultraviolet transmittance

Table 2-2. SWIFTRC Treatment Process Key Chemical Addition

Purpose	Chemical
Floc/Sed Coagulant	Aluminum Chlorohydrate
Flocculation Aid	Cationic Polymer
Bromate Inhibition	Preformed Monochloramine
Ozone and monochloramine Quenching	Sodium Bisulfite
Filter Aid	Non-Ionic Polymer
Nutrient amendment	Phosphoric acid
pH Adjustment	Sodium Hydroxide
Chlorine Disinfection	Sodium Hypochlorite/Preformed Monochloramine

It is important to acknowledge the role of the aquifer in providing additional treatment of the SWIFT Water. Due to the size of the PAS, the anticipated travel time of the recharge water is very slow; preliminary modeling has estimated the travel time to the three monitoring wells, located approximately between 400 and 500-feet from the injection well, should range from 3 to 12 months, depending on how recharge spreads across the 11 screens in TW-1 and the amount of hydrodynamic diffusion and dispersion encountered in each sand interval. Even using conservative assumptions, the modeling predicts that the recharge water will migrate in the PAS for decades before reaching the first users. HRSD is currently designing a soil column pilot test system to quantify the pathogen and organics removal capacity at the projected recharge travel time. Results of the soil column testing may provide insight on operational strategies of the SWIFTRC and design criteria for future full-scale facilities.

SECTION 3

Compliance Point Locations

Multiple compliance point locations have been identified for the SWIFTRC, as described below. Briefly, the compliance point locations will be:

1. At the wellhead to confirm that the SWIFT Water for recharge meets all of the regulatory limits in this document.
2. In the network of monitoring wells, not including MW-SAT, to confirm suitable compatibility of the SWIFT Water (described in Attachment C of this UIC Inventory).

The primary compliance point for the SWIFTRC will be at the wellhead, prior to entering the well. Sampling will be conducted at this location to confirm compliance with all SWIFT Water quality targets. Online analyzers throughout the treatment process will confirm that treatment performance is sufficient and critical control points (CCPs) will initiate action if performance is compromised. CCP failures will result in action that prevents inadequately treated water from being injected into the aquifer (see Table 6-1).

The network of monitoring wells around the recharge well (excluding MW-SAT) will be used as the final compliance point for the SWIFTRC. The purpose of these wells is detailed in Attachment C of this UIC Inventory. There is a separate suite of parameters that will be regulated in the monitoring wells that will confirm there is no adverse effect to the aquifer caused by recharge. Note that all of the proposed regulatory limits in this document are intended to be met at the wellhead.

SECTION 4

SWIFT Water Quality Targets for SWIFTRC

The SWIFT Water quality targets have been separated into two groups: regulatory parameters and performance indicators. The regulatory parameters must be achieved in order to continue the recharge flow to the PAS and will be supported by the CCPs. The performance indicators provide additional input on the performance of the treatment process and can help inform treatment or process decisions, but are not required to be actionable. The performance indicators are an acknowledgment that a higher level of treatment can be monitored and achieved.

4.1 SWIFTRC Regulatory Limits

Table 4-1 provides a list of the regulatory limits for the SWIFTRC. Most parameters have a treatment goal in addition to the regulatory limit. The treatment goals will be supported by the CCPs. Table 4-1 presents the complete list of regulatory requirements for the SWIFTRC to pump recharge water to the PAS. Quarterly reports detailing compliance with the regulatory limits will be provided to the U.S. Environmental Protection Agency (EPA). Copies of these reports will also be provided to the Virginia Department of Health, Office of Drinking Water.

Table 4-1. SWIFTRC Regulatory and Monitoring Limits for SWIFT Water

Parameter	Proposed Regulatory Limit	Non-Regulatory Action/Goal
EPA Drinking Water Primary Maximum Contaminant Levels (MCLs)	Meet all primary MCLs[1]	N/A
Total Nitrogen	5 mg/L Monthly Average; 8 mg/L Max Daily	Secondary Effluent CCP Action Limit for Total Inorganic Nitrogen = 6 mg/L-N
Turbidity	Individual Filter Effluent (IFE) <0.15 NTU 95% of time and never >0.3 NTU in two consecutive 15-minute measurements	CCP Action Limit IFE of 0.10 NTU to initiate backwash or place a filter in standby
Total Organic Carbon (TOC)[2]	4 mg/L Monthly Average 6 mg/L Maximum	Critical Operating Point (COP) Action Limit to Initiate GAC Regeneration; See Table 8 COP for GAC TOC
Total Coliform	<2 CFU/100 mL 95% of time Not to exceed geometric mean of 3 CFU/100 mL, based on a running calculation of 20 days of daily samples for total coliforms. E coli presence/absence will reported for each TC positive result	N/A
E. Coli	Non-Detect	N/A
TDS[3]	N/A	Monitor PAS Compatibility

[1] Refer to Table 7-2 for proposed sampling frequency of MCLs. Within 24 hours of notification from the HRSD or contract laboratory of a primary MCL violation, a confirmation sample will be collected and submitted for analysis. Within one hour of notification from the HRSD or contract laboratory that the primary MCL violation is confirmed, SWIFT Water will be diverted to the wastewater treatment facility until compliance with the primary MCL is demonstrated.

[2] Regulatory limit applies to the TOC laboratory analysis which is collected at a frequency of 3 times per week.

[3] Proposing no limit for TDS as the primary driver is aquifer compatibility. Expected range for SWIFT Water at SWIFTRC is 500-850 mg/L.

SECTION 5

Performance Indicators

Table 5-1 provides a list of performance indicators. These constituents are separated into those that are of public health interest and those that provide information on the effectiveness of treatment (*Final Report of an NWRI Independent Advisory Panel: Recommended DPR General Guidelines and Operational Requirements for New Mexico, 2016*). Table 5-1 provides information on where the criteria for each public health constituent was developed (many from the EPA contaminant candidate list [CCL4]) and the type of performance indicator. If the running average for any of the limits shown in Table 5-1 is exceeded, an investigation will be conducted to determine the best action to address the issue. This could include sampling at the monitoring well to determine removal by soil aquifer treatment (SAT), source control, modifying wastewater treatment, modifying advanced treatment, no action, or an alternative approach.

Table 5-1. SWIFTRC Non-Regulatory Performance Indicators

Constituent	Category	Value	Unit	Notes
1,4-Dioxane	Public Health	1	µg/L	CCL4; CA Notification Limit
17-β-Estradiol	Public Health	TBD	ng/L range	CCL4
DEET	Public Health	200	µg/L	MN Health Guidance Value
Ethinyl Estradiol	Public Health	TBD	ng/L range	CCL4
NDMA	Public Health	10	ng/L	CCL4; CA Notification Limit
Perchlorate	Public Health	6	µg/L	CA Notification Limit
PFOA+PFOS	Public Health	70	ng/L	CCL4; EPA Health Advisory
TCEP	Public Health	5	µg/L	MN Health Guidance Value
Cotinine	Treatment Effectiveness	1	µg/L	Surrogate for low molecular weight, partially charged cyclics
Primidone	Treatment Effectiveness	10	µg/L	
Phenytoin	Treatment Effectiveness	2	µg/L	
Meprobamate	Treatment Effectiveness	200	µg/L	High occurrence in wastewater treatment plant effluent
Atenolol	Treatment Effectiveness	4	µg/L	
Carbamazepine	Treatment Effectiveness	10	µg/L	Unique structure
Estrone	Treatment Effectiveness	320	µg/L	Surrogate for steroids
Sucralose	Treatment Effectiveness	150	mg/L	Surrogate for water soluble, uncharged chemicals with moderate molecular weight
Triclosan	Treatment Effectiveness	2,100	µg/L	Chemical of interest

TBD = to be determined

5.1 Design Pathogen Log Removal Value

Pathogen Log Removal Value (LRV) will not be strictly regulated but the SWIFTRC has been designed and will be operated to achieve at least 12 LRV for viruses and 10 LRV for *Cryptosporidium* and *Giardia* through a combination of advanced treatment processes and soil aquifer treatment. Tables 5-2 and 5-3 provide treatment process pathogen LRV summaries for the two end uses of the SWIFT Water: PAS recharge and tasting events.

5.2 PAS Recharge

The following key design and operational considerations and regulatory references are provided for context for Table 5-2:

- Two-log removal of viruses and 2.5-log *Giardia* removal is granted per the *Surface Water Treatment Rule Guidance Manual*, 1991 edition, section 5.5.2, for a well operated conventional filtration treatment plant.
- Three-log *Cryptosporidium* removal is granted per the *Long Term 2 Enhanced Surface Water Treatment Rule Toolbox Guidance Manual* section 1.4.1 if the combined filter effluent (CFE) is less than 0.3 NTU 95% of the time and never greater than 1.0 NTU. An additional 0.5-log credit is granted in section 7.2.1 for achieving individual filter effluent (IFE) of 0.15 NTU 95% of the time and having no two consecutive measurements 15 minutes apart greater than 0.3 NTU. One more additional 0.5-log credit is granted in section 7.2.1 for achieving CFE of 0.15 NTU 95% of the time. CCPs will be enacted to ensure that these turbidity requirements are met.
- Ozone: Prior to confirming pathogen removal that is achievable through SAT (see Attachment E), ozone will be operated to achieve 3-log reduction of viruses and 1.5-log reduction of *Giardia*. This is granted by maintaining a residual of 0.5 mg/L after 1.5 minutes with a baffling factor of 0.9 for a CT value of 0.675 (using Equations 11-2 and 11-3 of the *Long Term 2 Enhanced Surface Water Treatment Rule Toolbox Guidance Manual* at a historic 1% NP temperature of 13.4 degrees Celsius).
- The design Ultraviolet "UV" dose of 186 mJ/cm^2 provides 4-log removal of viruses according to Table 1.4 of the *Ultraviolet Disinfection Guidance Manual for the Final Long Term 2 Enhanced Surface Water Treatment Rule*. Extrapolation of this table estimates that 6-log *Cryptosporidium* and *Giardia* would be achieved at the design dose of 186 mJ/cm^2. Although no states currently accept 6-log inactivation of *Cryptosporidium* and *Giardia* for UV, it is widely accepted/acknowledged from a treatment aspect. The validation report for the UV disinfection reactor that will be installed in the SWIFTRC has been requested.
- The design intent is to feed a low monochloramine dose to the SWIFT Water only to prevent biological growth in the piping and well, not for disinfection LRV credit. However, free chlorine may be added instead of monochloramine to achieve 4-log virus removal depending on formation of disinfection byproducts and subsequent removal by SAT, as measured by the proposed soil column testing. If testing shows that this is viable, the ozone or UV dose may be decreased such that the treatment processes are still operated to achieve a total of 12 log removal of virus and 10 log removal of *Cryptosporidium* and *Giardia.*
- At least 6-log credit for viruses, *Cryptosporidium*, and *Giardia* is expected through SAT based on the modeled travel time of the recharge water in the PAS. Literature has demonstrated excellent treatment of recharge water as it moves through an aquifer system; the California Department of Health Regulations Related to Recycled Water section 60320.108 states that 1-log virus reduction credit is granted for every month the water is in the ground up to 6-log reduction. A minimum 6-log removal of *Cryptosporidium* and *Giardia* is expected when achieving 6-log virus reduction. HRSD's soil column testing will be used to confirm this assumption (see Attachment E).

The SWIFT RC is intended to be used to better understand how to optimize the treatment process for full-scale facilities. 12 log virus removal will be achieved at full-scale through some combination of SAT (based on documented soil column and SWIFT RC aquifer monitoring), flocculation/sedimentation/BAF (2 LRV), ozone (based on ability to control bromate formation), free chlorine disinfection (based on the need for this) and 186 mJ/cm2 ultraviolet disinfection (UVD). Once SAT removal and bromate formation

are better understood, the full-scale design criteria will be determined, though they may be site-specific based on different water quality.

Table 5-2. SWIFTRC Pathogen LRV for PAS Recharge Water

Parameter	Floc/Sed (+BAF)	Ozone	BAF+GAC	UV	Cl2	SAT	Total
Enteric Viruses	2	0-3(TBD)	0	4	0-4	6	12-19
Cryptosporidium	4	0	0	6	0	6	16
Giardia	2.5	0-1.5 (TBD)	0	6	0	6	14.5-16

5.3 Tasting

Flow for tasting events is diverted from the SWIFT Water flow prior to the wellhead. Tasting events will have a small batch tank that will allow for final confirmation of the water quality prior to consumption. This will include confirmation of a small chlorine residual only, not full testing of all SWIFT Water quality targets.

In addition to many similar design and operational considerations to Table 5-1, the following comments are provided for Table 5-3:

- Free chlorine will be added to the SWIFT Water for tasting events to achieve 4-log removal of viruses. SWIFT Water prior to injection will be piped to an approximate 200-gallon tank (in design) where sodium hypochlorite will be injected by a metering pump at an appropriate dose to achieve a 0.5 mg/L free chlorine residual. The tank will be designed to achieve a T10 time of 30-minutes and free chlorine will be measured in the tank effluent to confirm a residual of at least 0.5 mg/L, which results in a contact time (CT) of 15 mg-min/L. This is significantly higher than the required CT of 4.8 mg-min/L for 4-log virus removal at the historic 1% NP temperature of 13.4 degrees C (Table C-7 of the *Disinfection Profiling and Benchmarking Guidance Manual)*.
- During tasting events and perhaps also during normal recharge operations, ozone will be operated to achieve 3-log reduction of viruses and 1.5-log reduction of *Giardia*. This is granted by maintaining a residual of 0.5 mg/L after 1.5 minutes with a baffling factor of 0.9 for a CT value of 0.675 (using Equations 11-2 and 11-3 of the *Long Term 2 Enhanced Surface Water Treatment Rule Toolbox Guidance Manual* at a historic 1% NP temperature of 13.4 degrees Celsius).
- No credit for SAT is warranted as the water for the tasting event will be diverted upstream of the recharge well.
- The design Ultraviolet "UV" dose of 186 mJ/cm^2 provides 4-log removal of viruses according to Table 1.4 of the *Ultraviolet Disinfection Guidance Manual for the Final Long Term 2 Enhanced Surface Water Treatment Rule*. Extrapolation of this table estimates that 6-log *Cryptosporidium* and *Giardia* would be achieved at the design dose of 186 mJ/cm^2. Although no states currently accept 6-log inactivation of *Cryptosporidium* and *Giardia* for UV, it is widely accepted/acknowledged from a treatment aspect. The validation report for the UV disinfection reactor that will be installed in the SWIFTRC has been requested.

Table 5-3. SWIFTRC Pathogen LRV for Tasting Events

Parameter	Floc/Sed (+BAF)	Ozone	BAF+GAC	UV	Cl2	SAT	Total
Enteric Viruses	2	3	0	4	4	0	13
Cryptosporidium	4	0	0	6	0	0	10
Giardia	2.5	1.5	0	6	0	0	10

5.4 Full-Scale SWIFT Facility Considerations

The SWIFTRC and the soil column testing will provide significant operational data on the performance of the advanced treatment processes. Prior to design of full-scale facilities (not including the SWIFTRC), the design and operational parameters will be reevaluated. For example, as full-scale facilities will not be used for tasting events, pathogen LRVs may be reduced. This may include reduction of the pathogen credits provided by ozone, UV, and chlorine. If significant reduction of organics is demonstrated by soil column testing, for full-scale SWIFT build-out, HRSD may seek credit for Total Organic Carbon (TOC) reduction through SAT and modify the TOC regulatory limit at the wellhead accordingly.

SECTION 6

Critical Control Points

The SWIFTRC will incorporate CCPs throughout the treatment process, per Attachment G of this UIC Inventory to verify that treatment goals are being met at each of the individual processes. A violation of any CCP means that the SWIFTRC may not be producing water that meets the treatment goals and will trigger a diversion of the SWIFT Water so that it is not directed to the recharge well. In most instances, the SWIFTRC will continue to operate through the CCP violation, but the SWIFT Water will be diverted back to the Nansemond Plant chlorine contact tank.

CCPs have alert values at which point the operator is expected to take action to correct the performance as well as the alarm values at which point an automated response will trigger action and prevent flow from going to the recharge well. Both the alert and alarm values will be measured consistently for a specified duration before action is taken so that blips in online analyzers do not trigger action. Table 6-1 provides the preliminary list of CCPs for the SWIFTRC. The specific values for the alert and alarm levels will be configured as adjustable set points in the Distributed Control System and optimized as needed to meet the water quality requirements.

Table 6-1. Hazard Analysis and Critical Control Point: Critical Control Points and Critical Operating Parameters

Parameter	Alert Value	Alarm Value	Unit	Action
Critical Control Points (CCPs)				
Influent Pump Station Conductivity	1,000	1,500	microSiemens per centimeter	Divert settled water to drain pump station or stop influent pumps
Influent Pump Station Total Inorganic Nitrogen	5.0	6.0	mg/L	Divert settled water to drain pump station or stop influent pumps
Influent Pump Station Turbidity	15	20	NTU	Divert settled water to drain pump station or stop influent pumps
Preformed Chloramine Failure on Injection	N/A	Failure	mg/L	Divert SWIFT Water
Total Chlorine Post Injection upstream of ozone	2.0	1.0	mg/L	Divert SWIFT Water
Ozone Feed	N/A	Failure	N/A	Divert SWIFT Water and Open Biofilter Backwash Waste Valve
Ozone Contactor Calculated LRV – Virus	<120% LRV Goal	<100% LRV Goal	%	Divert SWIFT Water and Open Biofilter Backwash Waste Valve
Biofilter Individual Effluent Turbidity	0.1	0.15	NTU	Place filter in Standby at CCP at Alert Value. Divert filter effluent at Alarm Value
Biofilter Combined Filter Effluent Turbidity	0.1	0.15	NTU	Divert SWIFT Water
GAC Combined Effluent TOC, instantaneous online analyzer	4.0	6.0	mg/L	Divert SWIFT Water
UV Reactor Dose	<120% of Dose Setpoint	<105% of Dose Setpoint	%	Divert SWIFT Water
Free Chlorine CT[1]	<120% of CT Target	<105% of CT Target	%	Divert SWIFT Water

Table 6-1. Hazard Analysis and Critical Control Point: Critical Control Points and Critical Operating Parameters

Parameter	Alert Value	Alarm Value	Unit	Action
Critical Operating Parameters (COPs)				
NP Raw Wastewater Influent Conductivity	2,000	N/A	microSiemens per centimeter	None
NP Second Anoxic Zone Average Effluent Nitrate	5.0	N/A	mg/L	None
NP Reaeration Zone Average Dissolved Oxygen	1.0	N/A	mg/L	None
NP Aeration Basin Blower Function	Failure	N/A	N/A	Divert settled water to drain pump station
Influent Pump Station Nitrate	5.0	N/A	mg/L	None
Influent Pump Station Nitrite	0.5	N/A	mg/L	None
Influent Pump Station Ammonia	2.0	N/A	mg/L	None
Coagulant Feed	Failure	N/A	N/A	Divert settled water to drain pump station
Floc/sed Effluent Turbidity	2.0	5.0	NTU	Divert settled water to drain pump station
Monochloramine Post Injection upstream of ozone	2.0	1.0	mg/L	None
Oxidation-Reduction Potential Post Injection upstream of ozone	400	N/A	mV	None
Bisulfite Feed	Failure	N/A	N/A	None
Oxidation-Reduction Potential Post Bisulfite Feed Point	250	N/A	mV	None
Total Chlorine Post Bisulfite Feed Point	0.2	N/A	mg/L	None
Biofilter EBCT	< 5	N/A	mins	None
GAC Combined Effluent UVT	<90%	<85%	%	Divert SWIFT Water
GAC Combined Effluent TOC, previous 10-day average, lab	N/A	4.0	mg/L	Prepare for regeneration
GAC Combined Effluent Turbidity	0.3	N/A	NTU	None
GAC EBCT	< 15	N/A	mins.	None
Caustic Feed	Failure	N/A	N/A	None
Hypochlorite/Monochloramine Feed	Failure	N/A	N/A	None
Monochloramine Residual[2]	N/A	0.5	mg/L	Divert SWIFT Water
SWIFT Water pH	7.5>pH>7.7	7.3>pH>7.9	Standard Units	Divert SWIFT Water

[1] Free Chlorine CT only a CCP if free chlorination used for Virus inactivation.

[2] Monochloramine residual only a COP if monochloramine used for recharge well biogrowth control.

[3] The pH target for SWIFT Water is 7.6 to avoid mineral dissolution and precipitation. The allowable range is 7.5 – 7.7.

SECTION 7

Regulatory Sampling Plan

Sampling will be performed throughout the treatment process to verify treatment performance, online analyzer accuracy, and compliance with regulatory limits. A detailed sampling plan has been generated that addresses these purposes. Sampling will consist of a combination of onsite analysis, lab analysis performed by HRSD, and specialized analysis performed by outside contract labs. Table 7-1 provides the additional monitoring required to document compliance with the targeted LRV for the ozone and UV process units. Table 7-2 provides the sampling plan specific to the proposed regulatory limits and performance indicators including the location and frequency of each sample.

Table 7-1. Additional Monitoring to Support Ozone and UV LRV [1]

Ozone LRV
Ozone Influent Temperature
Ozone Influent Flow
Liquid Phase Ozone Concentration[2]
Contact Time
CT
UV LRV
UV Intensity, each reactor
UVT, GAC Combined Effluent
Reactor Flow, each
Calculated Dose, each Lamp
Status, each

[1] All continuous measurements. 15 min data will be submitted.

[2] The ozone liquid phase probe will be verified with lab grab samples performed at least once per week.

Table 7-2. SWIFTRC Regulatory and Process Monitoring Plan

HRSD SWIFT Research Center Regulatory and Process Monitoring Plan[1]									
Sample Location and Frequency (Regulated parameters for specific compliance points noted in bold, italic font)									
Parameter	**NP Influent**	**SWIFTRC Influent**	**Floc/Sed Effluent**	**Ozone Effluent**	**BAF IFE**	**BAF CFE**	**GAC CE**	**Tasting Tank**	**SWIFT Water**
Regulatory Parameters									
Total Nitrogen		Weekly			Monthly		Monthly		***Daily***
Nitrate (NO3-N) (SDWA PMCL)		Weekly			Monthly		Monthly		***Daily***
Nitrite-N (SDWA PMCL)		Weekly			Monthly		Monthly		***Daily***
Turbidity (SDWA PMCL)					**Continuous[2]**	**Continuous[2]**			
TOC		Weekly	3x/week		Monthly	3x/week	Continuou		***3x/week***
Total Coliform (SDWA PMCL)		Weekly							***Daily***
E. coli (SDWA PMCL)		Weekly							***Weekly***
Bromate (SDWA PMCL)				Daily					***Weekly***
Haloacetic acids (HAA5) (SDWA PMCL)									***Monthly***
Total trihalomethanes (SDWA PMCL)									***Monthly***
pH									***Continuous***
TDS									***Monthly***
Remaining EPA Primary MCLs									
Microorganisms									
Cryptosporidium	Quarterly	Quarterly							***Quarterly***
Giardia lamblia	Quarterly	Quarterly							***Quarterly***
Legionella		Quarterly							***Quarterly***
Disinfection Byproducts									
Chlorite	Monthly	Monthly							***Monthly***

Table 7-2. SWIFTRC Regulatory and Process Monitoring Plan

HRSD SWIFT Research Center Regulatory and Process Monitoring Plan[1]									
Sample Location and Frequency (Regulated parameters for specific compliance points noted in bold, italic font)									
Parameter	**NP Influent**	**SWIFTRC Influent**	**Floc/Sed Effluent**	**Ozone Effluent**	**BAF IFE**	**BAF CFE**	**GAC CE**	**Tasting Tank**	**SWIFT Water**
Disinfectants[3]									
Chloramines (as Cl_2)									***Continuous***[4]
Chlorine (as Cl_2)								As needed	***Continuous***[4]
Inorganic Chemicals									
Antimony, Total	Monthly	Monthly							***Monthly***
Arsenic, Total	Monthly	Monthly							***Monthly***
Asbestos	Monthly	Monthly							***Monthly***
Barium, Total	Monthly	Monthly							***Monthly***
Beryllium, Total	Monthly	Monthly							***Monthly***
Cadmium, Total	Monthly	Monthly							***Monthly***
Chromium, Total	Monthly	Monthly							***Monthly***
Copper, Total	Monthly	Monthly							***Monthly***
Cyanide, Total	Monthly	Monthly							***Monthly***
Fluoride	Monthly	Monthly							***Monthly***
Lead, Total	Monthly	Monthly							***Monthly***
Mercury, Total	Monthly	Monthly							***Monthly***
Selenium, Total	Monthly	Monthly							***Monthly***
Thallium, Total	Monthly	Monthly							***Monthly***
Organic Chemicals									
Acrylamide	Monthly	Monthly							***Monthly***

Table 7-2. SWIFTRC Regulatory and Process Monitoring Plan

HRSD SWIFT Research Center Regulatory and Process Monitoring Plan[1]									
Sample Location and Frequency (Regulated parameters for specific compliance points noted in bold, italic font)									
Parameter	**NP Influent**	**SWIFTRC Influent**	**Floc/Sed Effluent**	**Ozone Effluent**	**BAF IFE**	**BAF CFE**	**GAC CE**	**Tasting Tank**	**SWIFT Water**
Alachlor	Monthly	Monthly							***Monthly***
Atrazine	Monthly	Monthly							***Monthly***
Benzene	Monthly	Monthly							***Monthly***
Benzo(a)pyrene (PAHs)	Monthly	Monthly							***Monthly***
Carbofuran	Monthly	Monthly							***Monthly***
Carbon Tetrachloride	Monthly	Monthly							***Monthly***
Chlordane	Monthly	Monthly							***Monthly***
Chlorobenzene	Monthly	Monthly							***Monthly***
2,4-D	Monthly	Monthly							***Monthly***
Dalapon	Monthly	Monthly							***Monthly***
1,2-dibromo-3-chloropropane (DBCP)	Monthly	Monthly							***Monthly***
1,2-Dichlorobenzene (o-dichlorobenzene)	Monthly	Monthly							***Monthly***
1,4-Dichlorobenzene (p-dichlorobenzene)	Monthly	Monthly							***Monthly***
1,2-Dichloroethane	Monthly	Monthly							***Monthly***
1,1-Dichloroethylene	Monthly	Monthly							***Monthly***
cis-1,2-Dichloroethene	Monthly	Monthly							***Monthly***
trans-1,2-Dichloroethene	Monthly	Monthly							***Monthly***
Dichloromethane (Methylene chloride)	Monthly	Monthly							***Monthly***

Table 7-2. SWIFTRC Regulatory and Process Monitoring Plan

HRSD SWIFT Research Center Regulatory and Process Monitoring Plan[1]									
Sample Location and Frequency (Regulated parameters for specific compliance points noted in bold, italic font)									
Parameter	**NP Influent**	**SWIFTRC Influent**	**Floc/Sed Effluent**	**Ozone Effluent**	**BAF IFE**	**BAF CFE**	**GAC CE**	**Tasting Tank**	**SWIFT Water**
1,2-Dichloropropane	Monthly	Monthly							***Monthly***
Di(2-ethylhexyl) adipate	Monthly	Monthly							***Monthly***
Di(2-ethylhexyl) phthalate	Monthly	Monthly							***Monthly***
Dinoseb	Monthly	Monthly							***Monthly***
Dioxin (2,3,7,8-TCDD)	Monthly	Monthly							***Monthly***
Diquat	Monthly	Monthly							***Monthly***
Endothall	Monthly	Monthly							***Monthly***
Endrin	Monthly	Monthly							***Monthly***
Epichlorohydrin	Monthly	Monthly							***Monthly***
Ethylbenzene	Monthly	Monthly							***Monthly***
Ethylene dibromide (EDB)	Monthly	Monthly							***Monthly***
Glyphosate	Monthly	Monthly							***Monthly***
Heptachlor	Monthly	Monthly							***Monthly***
Heptachlor Epoxide	Monthly	Monthly							***Monthly***
Hexachlorobenzene	Monthly	Monthly							***Monthly***
Hexachlorocyclopentadiene	Monthly	Monthly							***Monthly***
Lindane (Gamma-BHC)	Monthly	Monthly							***Monthly***
Methoxychlor	Monthly	Monthly							***Monthly***
Oxamyl (Vydate)	Monthly	Monthly							***Monthly***
Polychlorinated biphenyls	Monthly	Monthly							***Monthly***

Table 7-2. SWIFTRC Regulatory and Process Monitoring Plan

HRSD SWIFT Research Center Regulatory and Process Monitoring Plan[1]									
Sample Location and Frequency (Regulated parameters for specific compliance points noted in bold, italic font)									
Parameter	**NP Influent**	**SWIFTRC Influent**	**Floc/Sed Effluent**	**Ozone Effluent**	**BAF IFE**	**BAF CFE**	**GAC CE**	**Tasting Tank**	**SWIFT Water**
AR1016	Monthly	Monthly							***Monthly***
AR1221	Monthly	Monthly							***Monthly***
AR1232	Monthly	Monthly							***Monthly***
AR1242	Monthly	Monthly							***Monthly***
AR1248	Monthly	Monthly							***Monthly***
AR1254	Monthly	Monthly							***Monthly***
AR1260	Monthly	Monthly							***Monthly***
Pentachlorophenol	Monthly	Monthly							***Monthly***
Picloram	Monthly	Monthly							***Monthly***
Simazine	Monthly	Monthly							***Monthly***
Styrene	Monthly	Monthly							***Monthly***
Tetrachloroethene	Monthly	Monthly							***Monthly***
Toluene	Monthly	Monthly							***Monthly***
Toxaphene	Monthly	Monthly							***Monthly***
2,4,5-TP (Silvex)	Monthly	Monthly							***Monthly***
1,2,4-Trichlorobenzene	Monthly	Monthly							***Monthly***
1,1,1-Trichloroethane	Monthly	Monthly							***Monthly***
1,1,2-Trichloroethane	Monthly	Monthly							***Monthly***
Trichloroethylene	Monthly	Monthly							***Monthly***
Vinyl Chloride	Monthly	Monthly							***Monthly***

Table 7-2. SWIFTRC Regulatory and Process Monitoring Plan

HRSD SWIFT Research Center Regulatory and Process Monitoring Plan[1]									
Sample Location and Frequency (Regulated parameters for specific compliance points noted in bold, italic font)									
Parameter	**NP Influent**	**SWIFTRC Influent**	**Floc/Sed Effluent**	**Ozone Effluent**	**BAF IFE**	**BAF CFE**	**GAC CE**	**Tasting Tank**	**SWIFT Water**
Xylene, Total	Monthly	Monthly							***Monthly***
Radionuclides									
Alpha particles (picocuries per liter [pCi/L])		Monthly							***Monthly***
Beta particles and photon emitters (pCi/L)		Monthly							***Monthly***
Radium 226 (pCi/L)		Monthly							***Monthly***
Radium 228 (pCi/L)		Monthly							***Monthly***
Uranium (µg/L)		Monthly							***Monthly***
Strontium-90[5]		Monthly							***Monthly***
Tritium[5]		Monthly							***Monthly***
Virginia Groundwater Protection Standards									
Aldrin/Dieldrin	Monthly	Monthly							***Monthly***
DDT	Monthly	Monthly							***Monthly***
Kepone	Monthly	Monthly							***Monthly***
Mirex	Monthly	Monthly							***Monthly***
Phenols	Monthly	Monthly							***Monthly***
Non-regulatory Parameters									
Performance Indicators									
Public Health Indicators									
1,4-dioxane	Quarterly	Quarterly							Quarterly

Table 7-2. SWIFTRC Regulatory and Process Monitoring Plan

HRSD SWIFT Research Center Regulatory and Process Monitoring Plan[1]									
Sample Location and Frequency (Regulated parameters for specific compliance points noted in bold, italic font)									
Parameter	**NP Influent**	**SWIFTRC Influent**	**Floc/Sed Effluent**	**Ozone Effluent**	**BAF IFE**	**BAF CFE**	**GAC CE**	**Tasting Tank**	**SWIFT Water**
17-β-estradiol	Quarterly	Quarterly							Quarterly
DEET	Quarterly	Quarterly							Quarterly
Ethinyl estradiol	Quarterly	Quarterly							Quarterly
NDMA	Quarterly	Quarterly		Weekly		Weekly			Quarterly
Perchlorate	Quarterly	Quarterly							Quarterly
PFOA + PFOS	Quarterly	Quarterly							Quarterly
tris(2-carboxyethyl)phosphine (TCEP)	Quarterly	Quarterly							Quarterly
Treatment Efficacy Indicators									
Cotinine	Quarterly	Quarterly							Quarterly
Primidone	Quarterly	Quarterly							Quarterly
Phenytoin	Quarterly	Quarterly							Quarterly
Meprobamate	Quarterly	Quarterly							Quarterly
Atenolol	Quarterly	Quarterly							Quarterly
Carbamazepine	Quarterly	Quarterly							Quarterly
Estrone	Quarterly	Quarterly							Quarterly
Sucralose	Quarterly	Quarterly							Quarterly
Triclosan	Quarterly	Quarterly							Quarterly
Non-regulatory Parameters with Aquifer Compatibility Focus									
Oxidation-Reduction Potential									Monthly
Specific Conductivity									Monthly

Table 7-2. SWIFTRC Regulatory and Process Monitoring Plan

HRSD SWIFT Research Center Regulatory and Process Monitoring Plan[1]									
Sample Location and Frequency (Regulated parameters for specific compliance points noted in bold, italic font)									
Parameter	**NP Influent**	**SWIFTRC Influent**	**Floc/Sed Effluent**	**Ozone Effluent**	**BAF IFE**	**BAF CFE**	**GAC CE**	**Tasting Tank**	**SWIFT Water**
Dissolved Oxygen									Monthly
Temperature									Monthly
Chloride, field									Monthly
Iron, field (ferrous as Fe^{2+})									Monthly
Iron, Total, field									Monthly
Alkalinity, field (as $CaCO_3$)									Monthly
Aluminum, dissolved									Monthly
Aluminum, total									Monthly
Arsenic, dissolved									Monthly
Iron, dissolved									Monthly
Iron, total									Monthly
Manganese, dissolved									Monthly
Manganese, total									Monthly
Magnesium, total									Monthly
Potassium, total									Monthly
Sodium, total									Monthly
Calcium, total									Monthly
Sulfate									Monthly
Chloride									Monthly
Alkalinity									Monthly

Table 7-2. SWIFTRC Regulatory and Process Monitoring Plan

HRSD SWIFT Research Center Regulatory and Process Monitoring Plan[1]									
Sample Location and Frequency (Regulated parameters for specific compliance points noted in bold, italic font)									
Parameter	**NP Influent**	**SWIFTRC Influent**	**Floc/Sed Effluent**	**Ozone Effluent**	**BAF IFE**	**BAF CFE**	**GAC CE**	**Tasting Tank**	**SWIFT Water**
Total Kjeldahl Nitrogen[6]		Weekly			Monthly		Monthly		*Daily*
Ammonia as N									Monthly
Total Phosphorus									Monthly
Orthophosphate as P									Monthly
Fluoride									Monthly
Silica as SiO_2									Monthly
Dissolved Organic Carbon									Monthly
Total Suspended Solids									Monthly
Hardness, Total									Monthly
Bypass Filtering Testing									Monthly
Microfouling Index Testing									Monthly
Additional monitoring with research focus (TBD by SWIFT Monitoring Program)									
Pathogens and Pathogen Indicators									
Adenovirus	Quarterly	Quarterly							Quarterly
Campylobacter	Quarterly	Quarterly							Quarterly
Norovirus GI	Quarterly	Quarterly							Quarterly
Norovirus GII	Quarterly	Quarterly							Quarterly
Enterovirus	Quarterly	Quarterly							Quarterly
Rotavirus	Quarterly	Quarterly							Quarterly

Table 7-2. SWIFTRC Regulatory and Process Monitoring Plan

HRSD SWIFT Research Center Regulatory and Process Monitoring Plan[1]									
Sample Location and Frequency (Regulated parameters for specific compliance points noted in bold, italic font)									
Parameter	**NP Influent**	**SWIFTRC Influent**	**Floc/Sed Effluent**	**Ozone Effluent**	**BAF IFE**	**BAF CFE**	**GAC CE**	**Tasting Tank**	**SWIFT Water**
Pepper Mild Mottle Virus	Quarterly	Quarterly							Quarterly
Male Specific Coliphages	Quarterly	Quarterly							Quarterly
Somatic Coliphages	Quarterly	Quarterly							Quarterly
CCL4& UCMR4 not included in above routine monitoring (parameters with commercially available analytical method)									
Total microcystin	Quarterly	Quarterly							Quarterly
Microcystin-LR	Quarterly	Quarterly							Quarterly
Anatoxin-a	Quarterly	Quarterly							Quarterly
Cylindrospermopsin	Quarterly	Quarterly							Quarterly
Germanium	Quarterly	Quarterly							Quarterly
Chlorpyrifos	Quarterly	Quarterly							Quarterly
Total permethrin (cis- and trans-)	Quarterly	Quarterly							Quarterly
Bromochloroacetic acid	Quarterly	Quarterly							Quarterly
Bromodichloroacetic aid	Quarterly	Quarterly							Quarterly
Dibromochloroacetic acid	Quarterly	Quarterly							Quarterly
Tribromoacetic acid	Quarterly	Quarterly							Quarterly
Quinoline	Quarterly	Quarterly							Quarterly
Bromide	Quarterly	Quarterly							Quarterly
1,1-dichloroethane	Quarterly	Quarterly							Quarterly
1,1,2,2-trichloroethane	Quarterly	Quarterly							Quarterly

Table 7-2. SWIFTRC Regulatory and Process Monitoring Plan

HRSD SWIFT Research Center Regulatory and Process Monitoring Plan[1]									
Sample Location and Frequency (Regulated parameters for specific compliance points noted in bold, italic font)									
Parameter	**NP Influent**	**SWIFTRC Influent**	**Floc/Sed Effluent**	**Ozone Effluent**	**BAF IFE**	**BAF CFE**	**GAC CE**	**Tasting Tank**	**SWIFT Water**
1,2,3-trichloropropane	Quarterly	Quarterly							Quarterly
1,3-butadiene	Quarterly	Quarterly							Quarterly
Acrolein	Quarterly	Quarterly							Quarterly
Aniline	Quarterly	Quarterly							Quarterly
Chlorate	Quarterly	Quarterly							Quarterly
Chloromethane	Quarterly	Quarterly							Quarterly
Cobalt	Quarterly	Quarterly							Quarterly
Diuron	Quarterly	Quarterly							Quarterly
Equilin	Quarterly	Quarterly							Quarterly
Erythromycin	Quarterly	Quarterly							Quarterly
Estriol	Quarterly	Quarterly							Quarterly
Formaldehyde	Quarterly	Quarterly							Quarterly
HCFC-22 (Chlorodifluoromethane)	Quarterly	Quarterly							Quarterly
Halon 1011 (bromochloromethane)	Quarterly	Quarterly							Quarterly
Hexane	Quarterly	Quarterly							Quarterly
Methanol	Quarterly	Quarterly							Quarterly
Methyl bromide	Quarterly	Quarterly							Quarterly
Methyl tert-butyl ether (MTBE)	Quarterly	Quarterly							Quarterly
Molybdenum	Quarterly	Quarterly							Quarterly
Nitrobenzene	Quarterly	Quarterly							Quarterly

Table 7-2. SWIFTRC Regulatory and Process Monitoring Plan

HRSD SWIFT Research Center Regulatory and Process Monitoring Plan[1]									
Sample Location and Frequency (Regulated parameters for specific compliance points noted in bold, italic font)									
Parameter	**NP Influent**	**SWIFTRC Influent**	**Floc/Sed Effluent**	**Ozone Effluent**	**BAF IFE**	**BAF CFE**	**GAC CE**	**Tasting Tank**	**SWIFT Water**
N-nitrosodiethylamine (NDEA)	Quarterly	Quarterly							Quarterly
N-nitroso-di-n-propylamine (NDPA)	Quarterly	Quarterly							Quarterly
N-nitrosodiphenylamine	Quarterly	Quarterly							Quarterly
N-nitrosopyrrolidine (NPYR)	Quarterly	Quarterly							Quarterly
Nonylphenol	Quarterly	Quarterly							Quarterly
Norethindrone	Quarterly	Quarterly							Quarterly
Permethrin	Quarterly	Quarterly							Quarterly
sec-Butylbenzene	Quarterly	Quarterly							Quarterly
Tellurium	Quarterly	Quarterly							Quarterly
Vanadium	Quarterly	Quarterly							Quarterly
Additional analytes not included in UCMR4 or CCL4[7]									
BDE-100	Quarterly	Quarterly							Quarterly
BDE-153	Quarterly	Quarterly							Quarterly
BDE-154	Quarterly	Quarterly							Quarterly
BDE-183	Quarterly	Quarterly							Quarterly
BDE-209	Quarterly	Quarterly							Quarterly
BDE-28	Quarterly	Quarterly							Quarterly
BDE-47	Quarterly	Quarterly							Quarterly
BDE-99	Quarterly	Quarterly							Quarterly

Table 7-2. SWIFTRC Regulatory and Process Monitoring Plan

HRSD SWIFT Research Center Regulatory and Process Monitoring Plan[1]									
Sample Location and Frequency (Regulated parameters for specific compliance points noted in bold, italic font)									
Parameter	**NP Influent**	**SWIFTRC Influent**	**Floc/Sed Effluent**	**Ozone Effluent**	**BAF IFE**	**BAF CFE**	**GAC CE**	**Tasting Tank**	**SWIFT Water**
Tris(2-chloroethyl) phosphate (TCPP)	Quarterly	Quarterly							Quarterly
Tris(1,3-dichloro-2-propyl)phosphate (TDCPP)	Quarterly	Quarterly							Quarterly
Androstenedione	Quarterly	Quarterly							Quarterly
Estradiol	Quarterly	Quarterly							Quarterly
Estriol	Quarterly	Quarterly							Quarterly
Progesterone	Quarterly	Quarterly							Quarterly
Theobromine	Quarterly	Quarterly							Quarterly
1,7-Dimethylxanthine	Quarterly	Quarterly							Quarterly
Acesulfame-K	Quarterly	Quarterly							Quarterly
Butylparaben	Quarterly	Quarterly							Quarterly
Caffeine	Quarterly	Quarterly							Quarterly
Ethylparaben	Quarterly	Quarterly							Quarterly
Isobutylparaben	Quarterly	Quarterly							Quarterly
Methylparaben	Quarterly	Quarterly							Quarterly
Musk ketone	Quarterly	Quarterly							Quarterly
Propylparaben	Quarterly	Quarterly							Quarterly
Triclocarban (TCC)	Quarterly	Quarterly							Quarterly
Acetominophen	Quarterly	Quarterly							Quarterly
Albuterol	Quarterly	Quarterly							Quarterly

Table 7-2. SWIFTRC Regulatory and Process Monitoring Plan

HRSD SWIFT Research Center Regulatory and Process Monitoring Plan[1]									
Sample Location and Frequency (Regulated parameters for specific compliance points noted in bold, italic font)									
Parameter	**NP Influent**	**SWIFTRC Influent**	**Floc/Sed Effluent**	**Ozone Effluent**	**BAF IFE**	**BAF CFE**	**GAC CE**	**Tasting Tank**	**SWIFT Water**
Amoxicillin	Quarterly	Quarterly							Quarterly
Atenolol	Quarterly	Quarterly							Quarterly
Azithromycin	Quarterly	Quarterly							Quarterly
Bendroflumethiazide	Quarterly	Quarterly							Quarterly
Bezafibrate	Quarterly	Quarterly							Quarterly
Butalbital	Quarterly	Quarterly							Quarterly
Carbadox	Quarterly	Quarterly							Quarterly
Carisoprodol	Quarterly	Quarterly							Quarterly
Chloramphenicol	Quarterly	Quarterly							Quarterly
Cimetidine	Quarterly	Quarterly							Quarterly
Clofibric acid	Quarterly	Quarterly							Quarterly
Dehydronifedipine	Quarterly	Quarterly							Quarterly
Diazepam	Quarterly	Quarterly							Quarterly
Diclofenac	Quarterly	Quarterly							Quarterly
Dilantin	Quarterly	Quarterly							Quarterly
Diltiazem	Quarterly	Quarterly							Quarterly
Flumequine	Quarterly	Quarterly							Quarterly
Fluoxetine	Quarterly	Quarterly							Quarterly
Galaxolide	Quarterly	Quarterly							Quarterly
Gemfibrozil	Quarterly	Quarterly							Quarterly

Table 7-2. SWIFTRC Regulatory and Process Monitoring Plan

HRSD SWIFT Research Center Regulatory and Process Monitoring Plan[1]									
Sample Location and Frequency (Regulated parameters for specific compliance points noted in bold, italic font)									
Parameter	**NP Influent**	**SWIFTRC Influent**	**Floc/Sed Effluent**	**Ozone Effluent**	**BAF IFE**	**BAF CFE**	**GAC CE**	**Tasting Tank**	**SWIFT Water**
Ibuprofen	Quarterly	Quarterly							Quarterly
Iohexol	Quarterly	Quarterly							Quarterly
Iopromide	Quarterly	Quarterly							Quarterly
Ketoprofen	Quarterly	Quarterly							Quarterly
Keterolac	Quarterly	Quarterly							Quarterly
Lidocaine	Quarterly	Quarterly							Quarterly
Lincomycin	Quarterly	Quarterly							Quarterly
Linuron	Quarterly	Quarterly							Quarterly
Lopressor	Quarterly	Quarterly							Quarterly
Meclofenamic acid	Quarterly	Quarterly							Quarterly
Naproxen	Quarterly	Quarterly							Quarterly
Nifedipine	Quarterly	Quarterly							Quarterly
Oxolinic acid	Quarterly	Quarterly							Quarterly
Pentoxyfylline	Quarterly	Quarterly							Quarterly
Phenazone	Quarterly	Quarterly							Quarterly
Propazine	Quarterly	Quarterly							Quarterly
Sulfachloropyridazine	Quarterly	Quarterly							Quarterly
Sulfadiazine	Quarterly	Quarterly							Quarterly
Sulfadimethoxine	Quarterly	Quarterly							Quarterly
Sulfamerazine	Quarterly	Quarterly							Quarterly

Table 7-2. SWIFTRC Regulatory and Process Monitoring Plan

HRSD SWIFT Research Center Regulatory and Process Monitoring Plan[1]									
Sample Location and Frequency (Regulated parameters for specific compliance points noted in bold, italic font)									
Parameter	**NP Influent**	**SWIFTRC Influent**	**Floc/Sed Effluent**	**Ozone Effluent**	**BAF IFE**	**BAF CFE**	**GAC CE**	**Tasting Tank**	**SWIFT Water**
Sulfamethazine	Quarterly	Quarterly							Quarterly
Sulfamethizole	Quarterly	Quarterly							Quarterly
Sulfamethoxazole	Quarterly	Quarterly							Quarterly
Sulfathiazole	Quarterly	Quarterly							Quarterly
Theophylline	Quarterly	Quarterly							Quarterly
Thiabendazole	Quarterly	Quarterly							Quarterly
Trimethoprim	Quarterly	Quarterly							Quarterly
Warfarin	Quarterly	Quarterly							Quarterly
Bromacil	Quarterly	Quarterly							Quarterly
Chloridazon	Quarterly	Quarterly							Quarterly
Chlorotoluron	Quarterly	Quarterly							Quarterly
Cyanazine	Quarterly	Quarterly							Quarterly
Diaminochloro-atrazine (DACT)	Quarterly	Quarterly							Quarterly
Desethyl-atrazine (DEA)	Quarterly	Quarterly							Quarterly
Desisopropyl-atrazine (DIA)	Quarterly	Quarterly							Quarterly
Fenitrothion	Quarterly	Quarterly							Quarterly
Fipronil	Quarterly	Quarterly							Quarterly
Isoproturon	Quarterly	Quarterly							Quarterly
Kepone	Quarterly	Quarterly							Quarterly
Metazachlor	Quarterly	Quarterly							Quarterly

Table 7-2. SWIFTRC Regulatory and Process Monitoring Plan

HRSD SWIFT Research Center Regulatory and Process Monitoring Plan[1]									
Sample Location and Frequency (Regulated parameters for specific compliance points noted in bold, italic font)									
Parameter	**NP Influent**	**SWIFTRC Influent**	**Floc/Sed Effluent**	**Ozone Effluent**	**BAF IFE**	**BAF CFE**	**GAC CE**	**Tasting Tank**	**SWIFT Water**
Sulfometuron, methyl	Quarterly	Quarterly							Quarterly

[1] All samples are collected as grabs unless denoted as “Continuous”. 15-minute data will be reported for each continuous measurement.

[2] All in service turbidimeters will be verified with daily lab grabs. Both grab and 15 min turbidimeter data will be submitted for IFE and CFE. If a turbidimeter is out of service, unreliable or suspect, turbidity samples will be collected by grab for lab analysis every 4 hours.

[3] ClO_2 not used for disinfection and therefore is not included in monitoring.

[4] Continuous measurements of chlorine and chloramines will be confirmed with a daily grab.

[5] Required by the Virginia Department of Health to determine vulnerability due to potential contribution from military bases.

[6] TKN monitoring frequency to match TN monitoring frequency as TKN is needed for the calculation of TN. If HRSD sufficiently demonstrates comparability of the direct measurement of TN to VDH and DEQ satisfaction, TKN frequency will be reduced such that TKN will only be measured in the SWIFT Water on a monthly basis.

[7] Additional parameters for research focus beyond the CCL4 and UCMR 4 parameters are subject to change based on occurrence data at the SWIFTRC and in secondary effluent at future SWIFT facilities.